SmartGrid aktiviteterne på Bornholm

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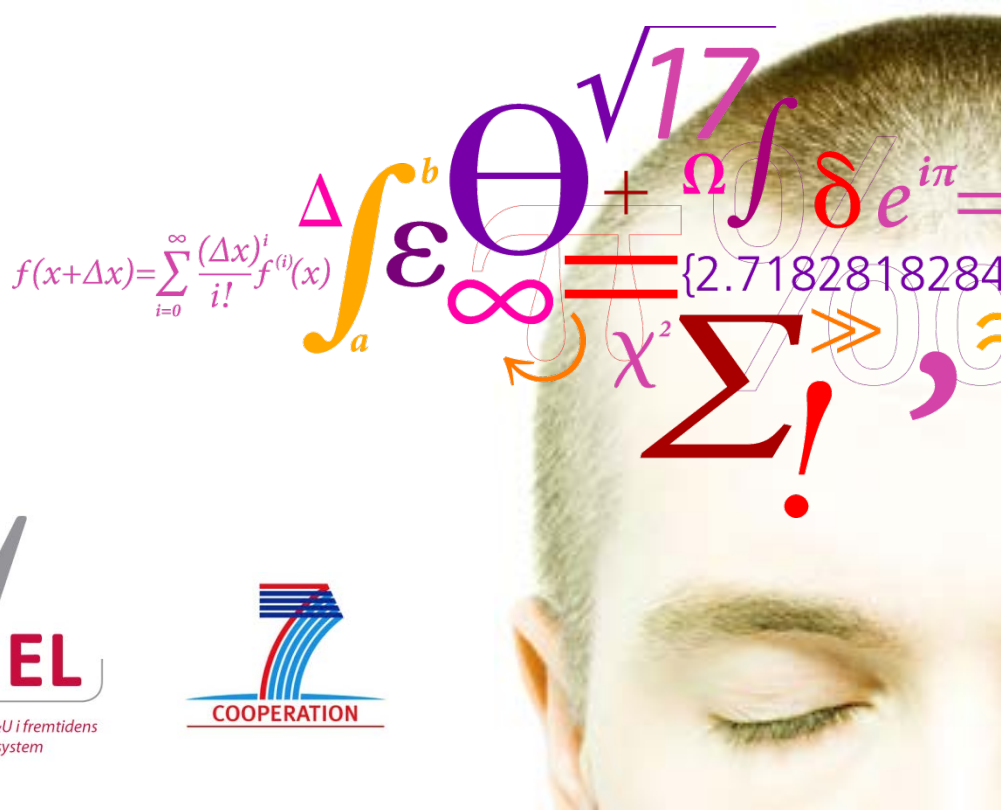


Center for Electric Power and Energy (CEE)
DTU Electrical Engineering

- CEE established 15 August 2012 as a merger of existing units:
  - Center for Electric Technology, DTU Electrical Engineering
  - Intelligent Energy Systems, Risø National Laboratory for Sustainable Energy

- Provide cutting-edge research, education and innovation to meet the future needs of society regarding a reliable, cost efficient and sustainable energy system

- A strong university centers
  - 90 employees
  - Discipline oriented research, application-driven research and proof-of-concepts
  - Bachelor, master and PhD degree programs

- Broad collaboration nationally and internationally

- Strategic partnerships

ENERGINET.DK DONG energy SIEMENS

The Bornholm Energy System

BRIGHT GREEN ISLAND
BORNHOLM
1st Edition, 2008

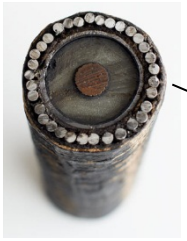
Bright Green Island is the vision of a completely green and sustainable island community which leads the way in showing that the future belongs to those who invent it.

Bornholm energy mix:

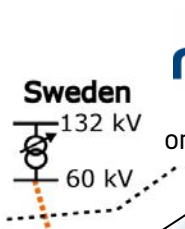
Wind **64**%
Biomass **10**%
Sun **1**%
Coal **18**%
Oil **7**%

Bornholm

Second-to-None Renewable Energy Demonstration Area



One connection point.

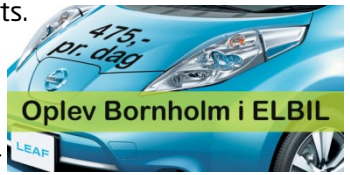


nordpool spot

Interconnected or isolated operation.

Approx. 1% of DK (population, area, energy demand).

Smart Grid ready PV plants.



EV roll-out.

Combined head & power (33 MW).

Modern wind turbines.
33% penetration.

Biogas plant (2 MW).

Five biomass fired district heating systems.

60 kV ring structure grid.

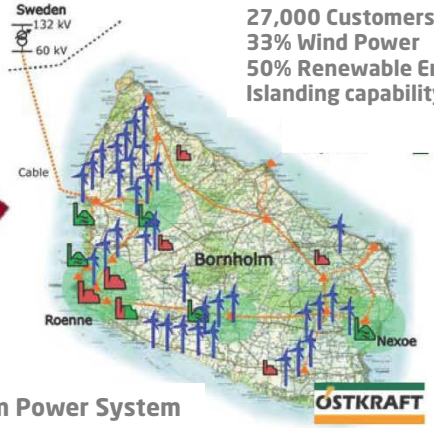
PowerLabDK combines experimental facilities

Flexible multi-purpose laboratories

Lyngby &
Ballerup Campus

Large-scale test system

Risø Campus



27,000 Customers
33% Wind Power
50% Renewable Energy
Islanding capability

Full-scale Realistic Power System

Bornholm Power System

Stakeholders:

ABB, nkt cables, dansk energi, SIEMENS, DONG energy, VATTENFALL, ENERGINET.DK, Vestas, IBM

Supported by:

GREEN LABS DK, eUDP

Investment:
18 million Euro

PowerLabDK

Intelligent Control Lab

Power system simulation, control and supervision

www.powerlab.dk

DTU Technical University of Denmark

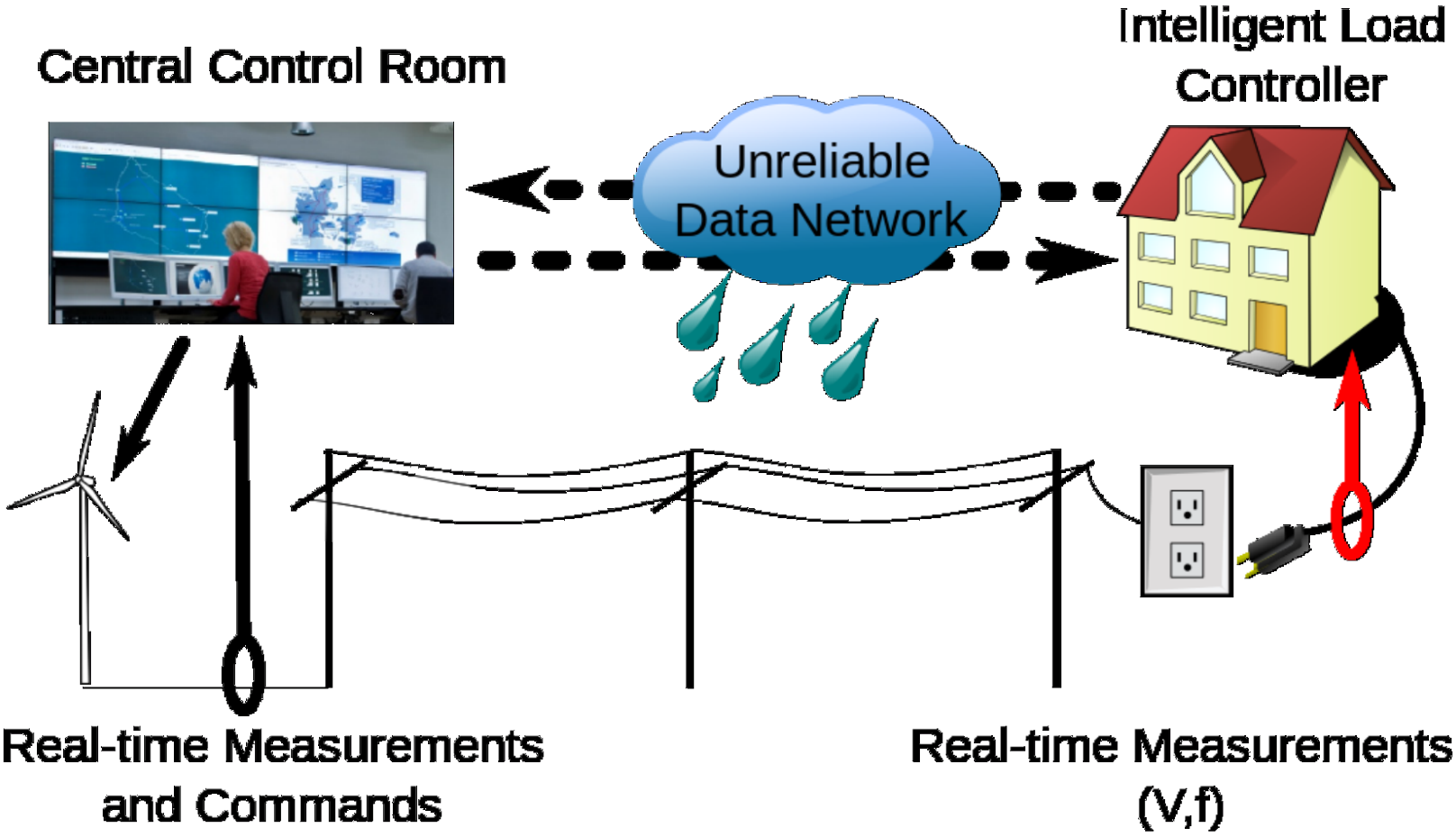
INGENIØR HØJSKOLEN KØBENHAVN – University College

ØSTKRAFT
energi til gode oplevelser

Smart Grid and Smart Energy Projects at Bornholm

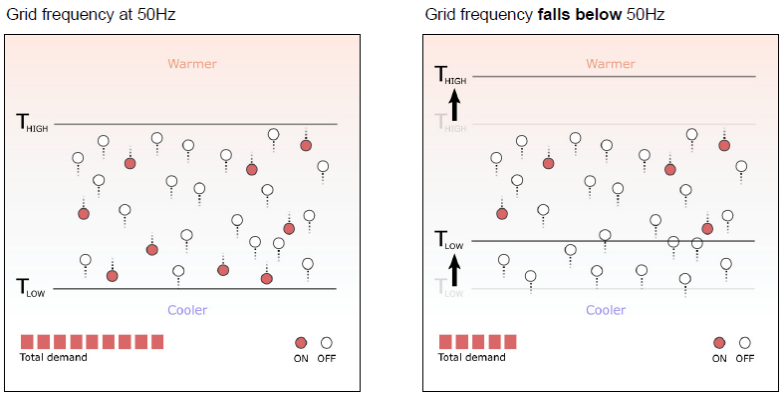
1. New market designs
2. Flexibility from demand and distributed energy resources
3. Distribution grid automation
4. Services from wind turbines, solar power plants and electric vehicles
5. Customer acceptance
6. Optimisation of the complete energy system, electricity/heat/gas

Smart Grid Solutions Utilising Demand Flexibility



Frequency

System Reserves Provided by Frequency Responsive Electricity Demand



$$T_{high} = T_{high}^{normal} - kf\,(f - f_0)$$

$$T_{low} = T_{low}^{normal} - kf\,(f - f_0)$$

Field test w. 200 residential, commercial and industrial demand units

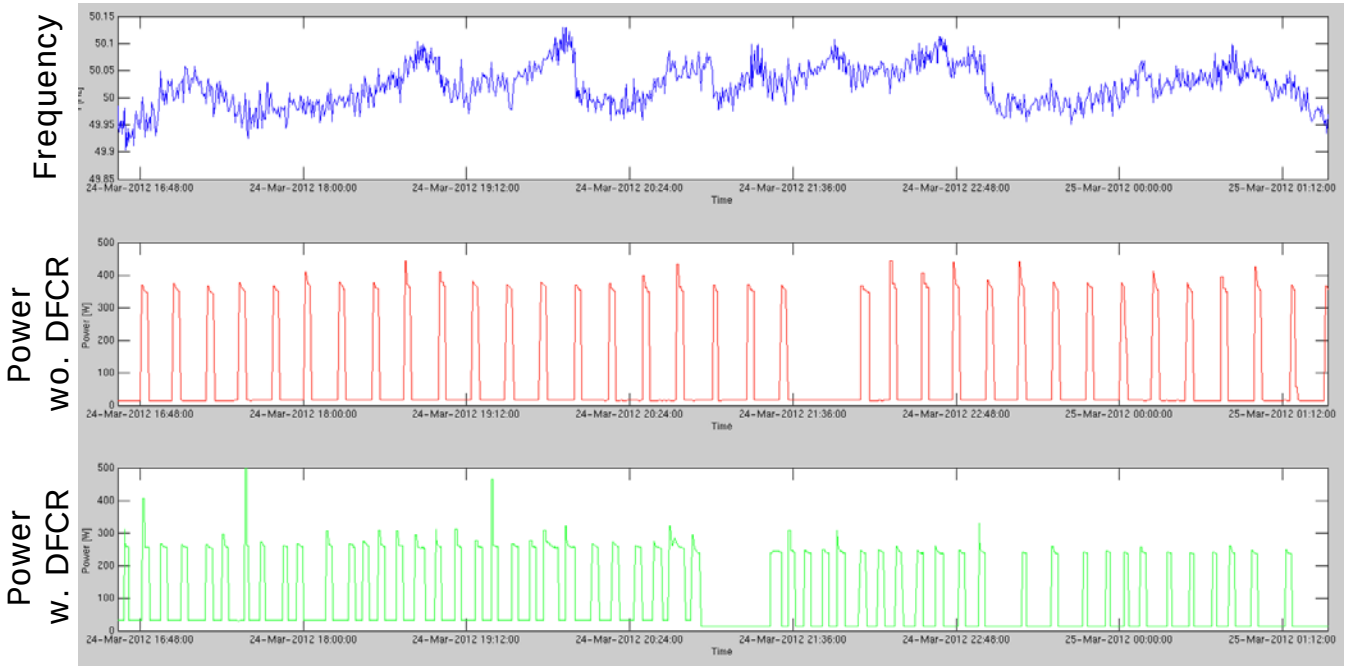
Field test at Bornholm

Refs: *IEEE Transactions on Power Systems*, August 2011.
IET Generation Transmission and Distribution, August 2009.

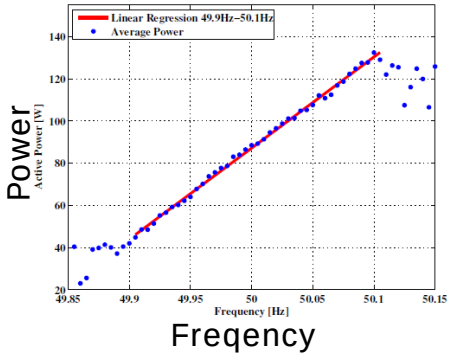
System Reserves Provided by Frequency Responsive Electricity Demand

Field measurements

Operation of single bottle cooler



Delivery of normal reserve (49.9-50.1 Hz)



Delivery of disturbance reserve (<49.9 Hz)

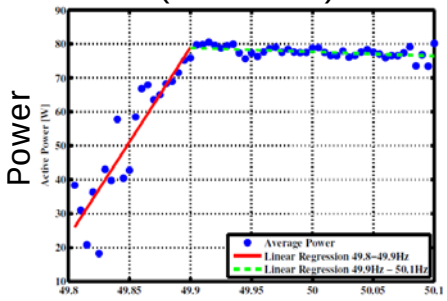
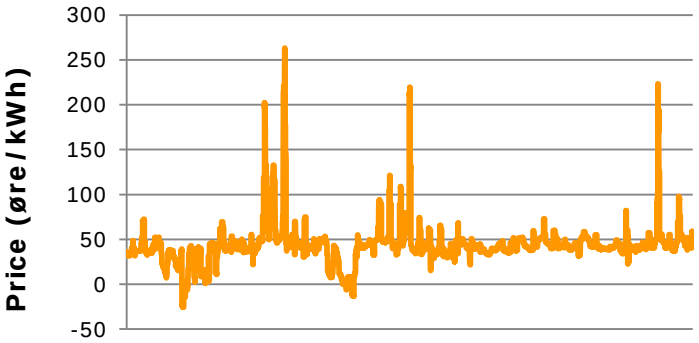


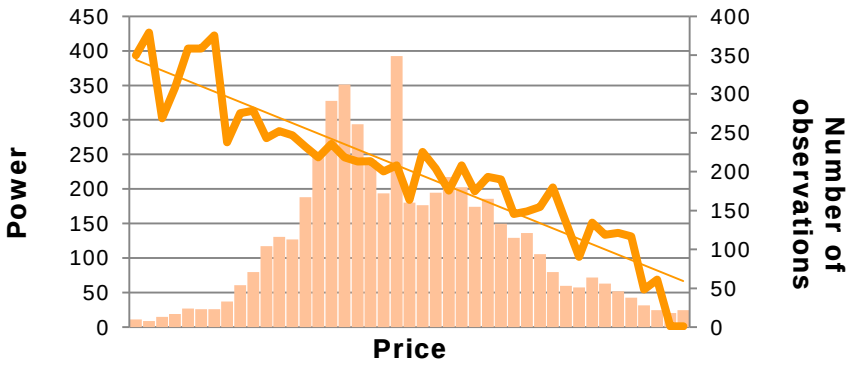
Figure 9. Frequen ng as a disturbance reserve, shown with gression in regions above and below 49.90 Hz.

- Demand can with maintained energy service deliver reserves which today are delivered by large power plants
- Simple pay back time = **1-2½** year w/ 1 kW unit
- Easy implementation supporting commercialization

FlexPower Project

- Goal: Activate flexibility by sending real-time price signals to end-users
  - Demand and distributed energy resources
  - Simple for end-user
  - No bidding
  - No promised reaction
  - No complicated settlement
- Co-exist with current market structure
- Technology neutral
  - Same price is sent to each unit, but parameters for the various units can of course differ.

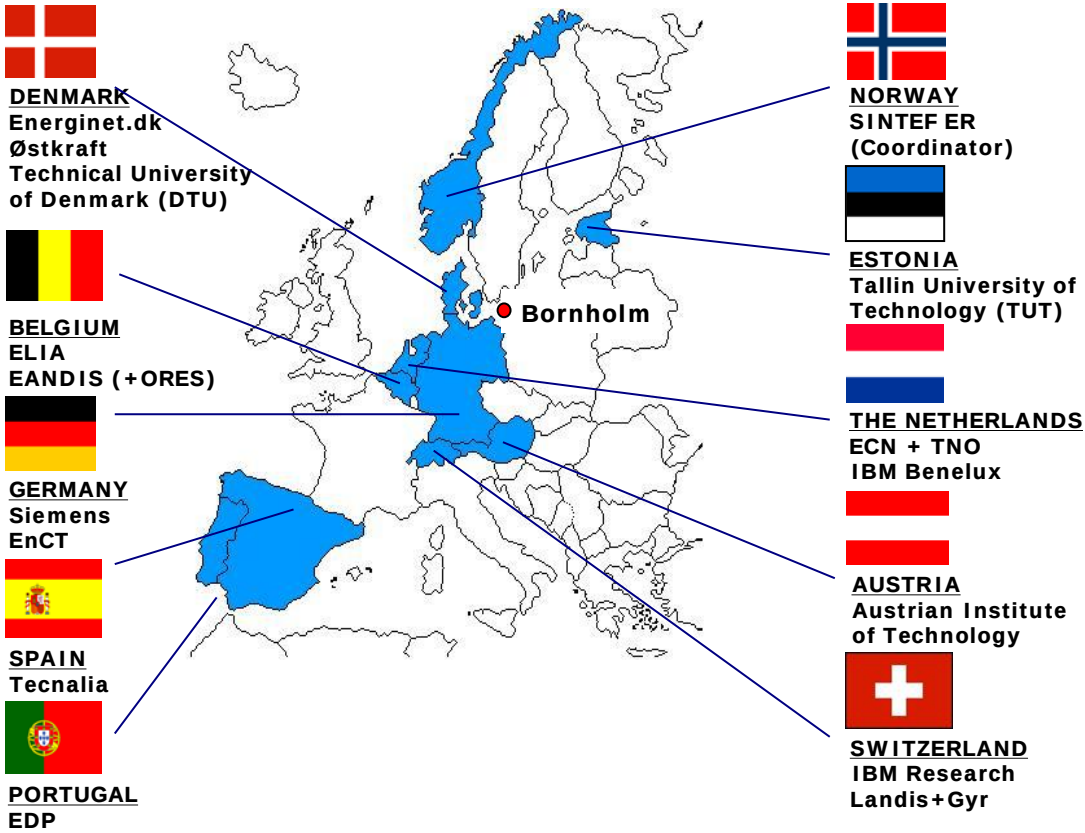




EcoGrid EU

Large-scale demonstration of the future intelligent distribution system

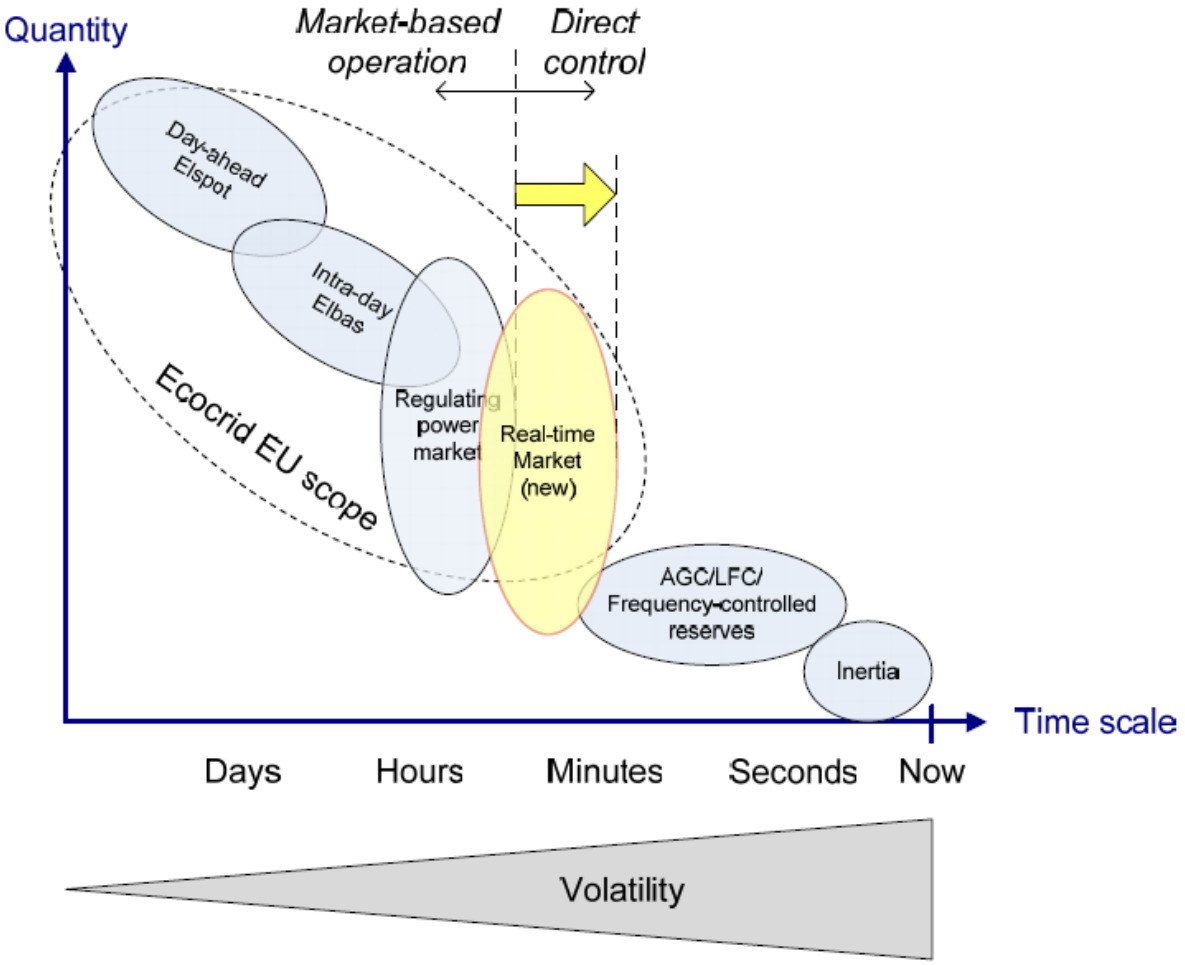
- EU FP7 ENERGY
- 2011-14
- Budget: 21 million Euro
- Integrated research and demonstration
- 2,000 active customers
- EU fast-track to Smart Grids



COOPERATION

Extention of the Market Solutions

Smaller Units and Shorter Time Constants



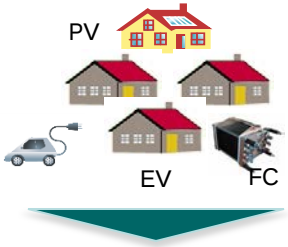
EcoGrid EU participants

- 200 customers in the control group
- 500 ordinary households. Will be equipped with smart meter. Price prognosis send daily. Price warnings when price exceed certain levels
- 700 IBM/PowerMatcher households. Get smart meter and home automation system. Primarily electric heated or heat pump households
- 500 Siemens households. Get smart meter and home automation system. Primarily electric heated or heat pump households
- 100 businesses with smart meter and energy management system

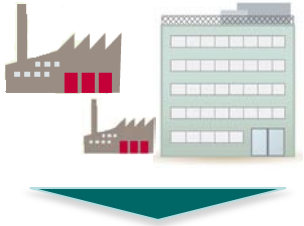
Control group

Manual control user

IBM / PowerMatcher users



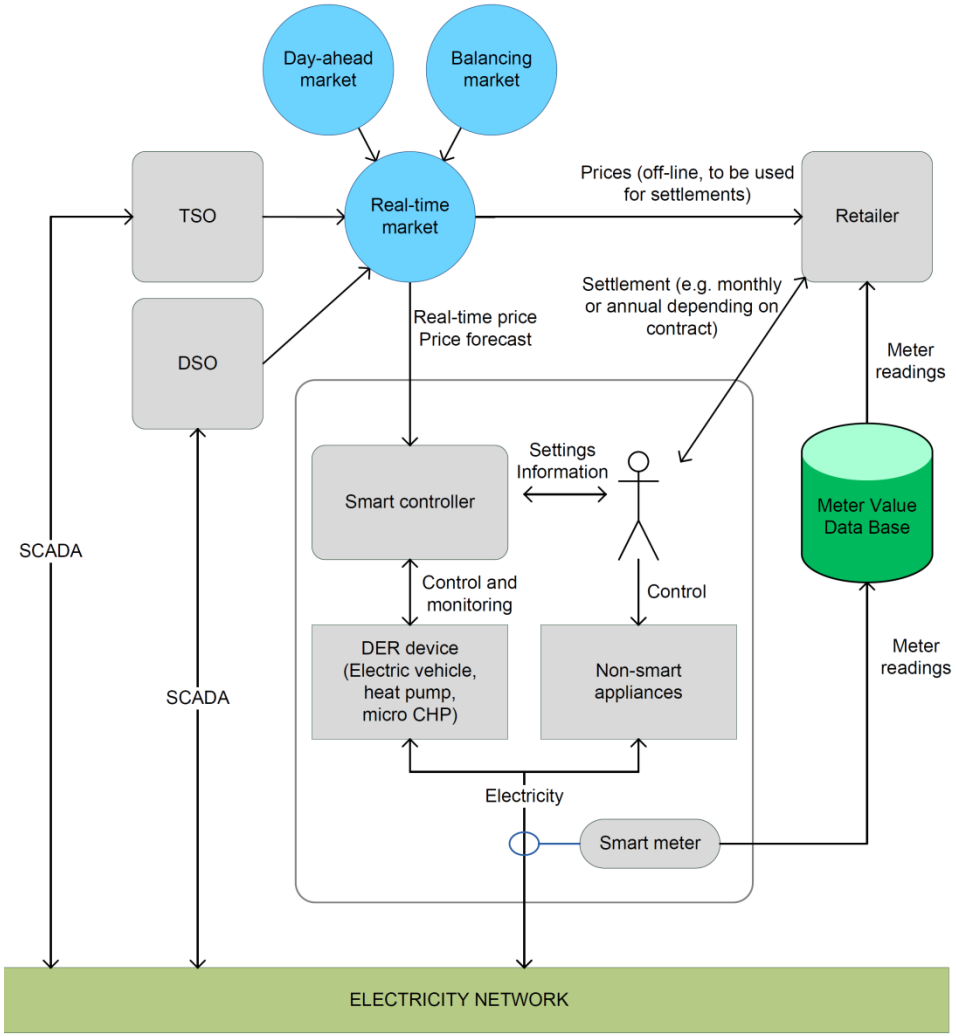
Siemens users



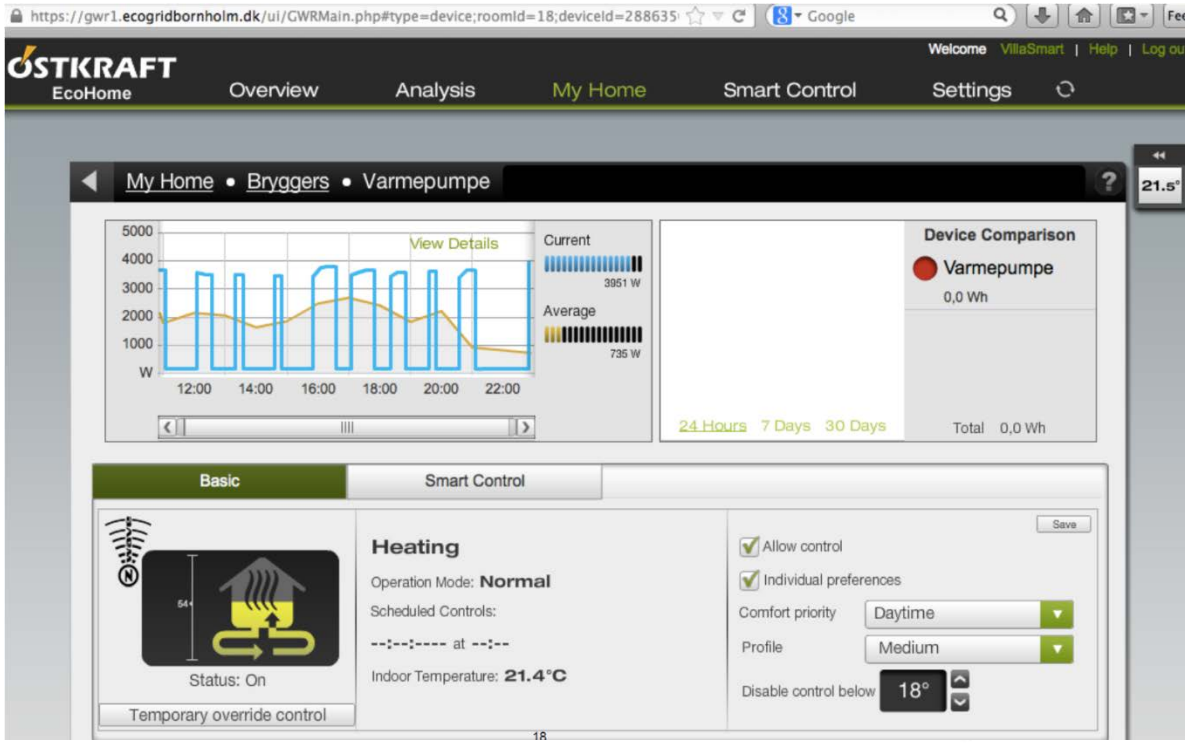
Smart businesses

15

EcoGrid EU Basic Concept

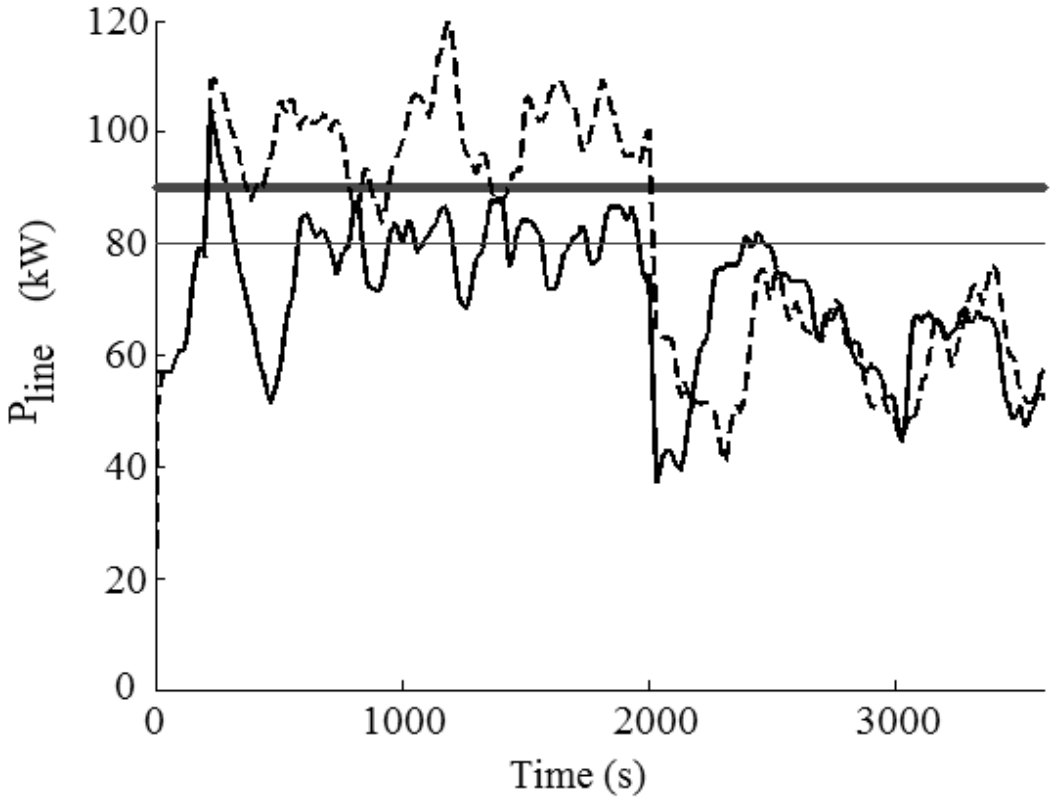


EcoGrid EU User Interface



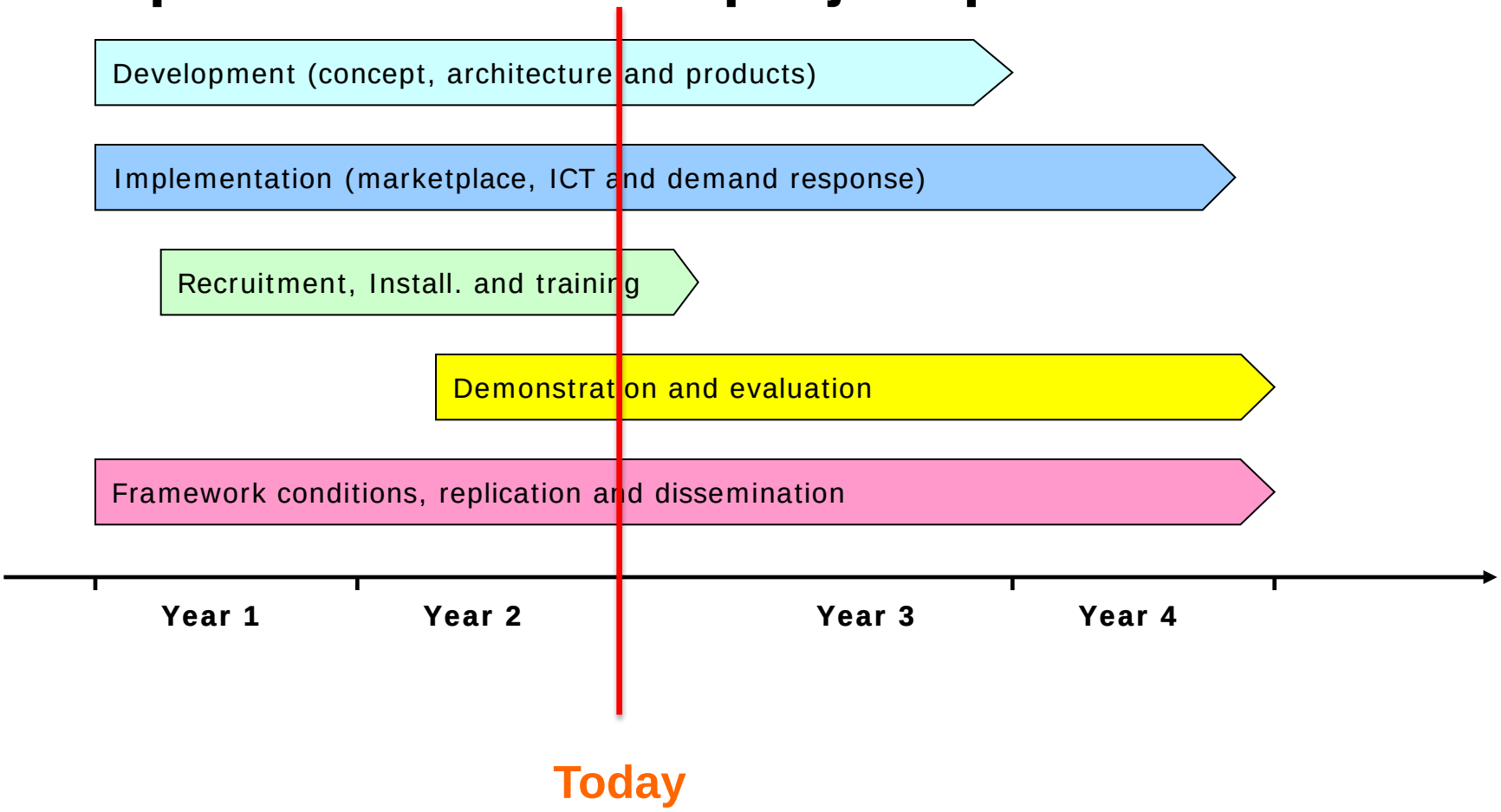
Overload Elimination in Distribution System

Based on 5 min real-time prices

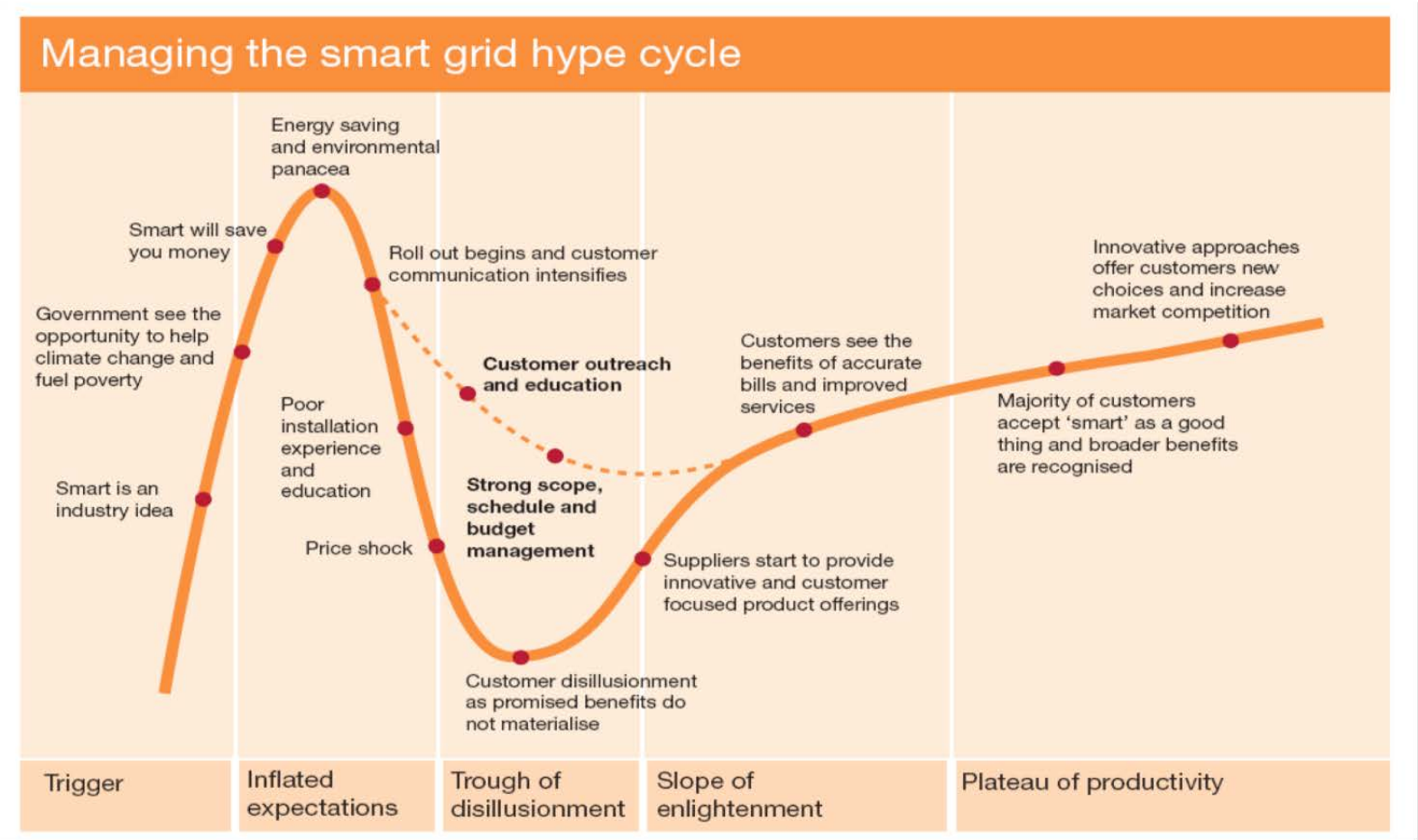


Source: To be presented at IEEE ISGT Europe 2011.

Simplified EcoGrid EU project plan



Involving End Consumers

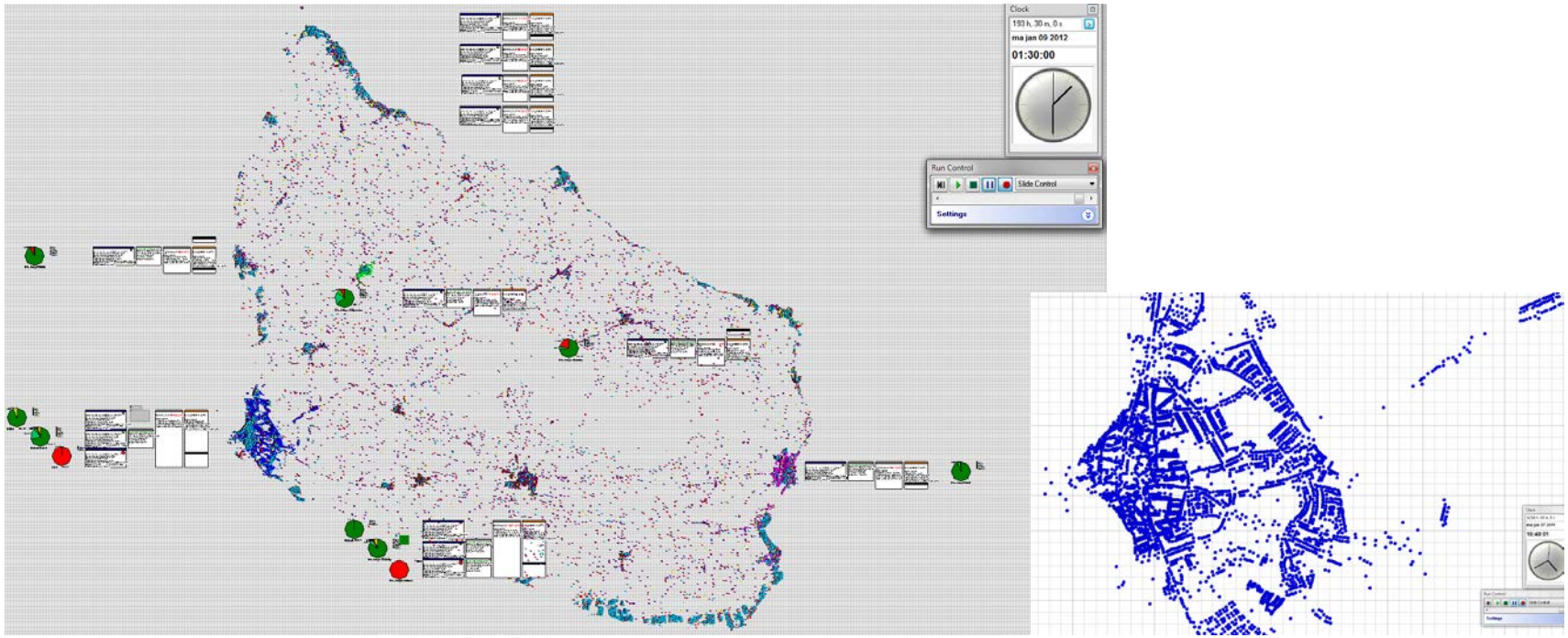


Source: "Smart from the Start – Managing Smart Grid Programmes", PwC, 2010

BGTI Modellen

- Værktøj til beslutningstagning vedr. optimering af det samlede energisystem mht. drift, økonomi og miljøbelastning

- Integrerer alle dele: kunder, infrastrukturer, produktion og lagre



Conclusion

- The Bornholm energy system is a unique and second-to-none demonstration area.
- New innovative technology is developed in several projects.
- The projects are aligned with the overall strategy for the island, Bright Green Island.
- Synergy between existing projects and infrastructures is obtained resulting in cost-effective demonstration.

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